

WHAT IS CLAIMED IS:

1. A system for inspecting a specimen,
comprising:

an illumination system comprising an arc lamp
5 able to provide light energy having a wavelength in
the range of approximately 285 to 320 nanometers; and

an imaging subsystem oriented and configured to
receive said light energy from said illumination
system and direct light energy toward said specimen,
10 said imaging subsystem comprising a plurality of
lenses and having a field size, wherein a ratio of
lens diameter to field size is less than 100 to 1.

2. The system of claim 1, wherein said imaging
subsystem further comprises a mangin mirror
15 arrangement.

3. The system of claim 1 where the arc lamp has
the ability to operate at wavelengths from 266-320nm.

4. The system of claim 1 where the illumination
subsystem includes a laser.

20 5. The system of claim 1, further comprising
collection optics for collecting light energy
reflected from said specimen, wherein the collection
optics are catadioptric.

6. The system of claim 1 where the imaging and
25 illumination subsystems support at least one of a
group of inspection modes comprising bright field,
ring dark field, directional dark field, full sky,
aerial imaging, confocal, and fluorescence.

7. The system of claim 1 where the imaging subsystem uses a varifocal system for the full magnification range.

8. The system of claim 1 where separate imaging
5 lenses are used for specific magnification increments.

9. The system of claim 1, further comprising a data analysis subsystem for analyzing data representing the light energy reflected from the specimen, wherein the data analysis subsystem has the
10 ability to record defect position for any defect on the specimen.

10. A system for inspecting a specimen, comprising:

an illumination subsystem able to transmit light
15 energy having a wavelength in the range of approximately 157 nanometers through the infrared light range;

an imaging subsystem comprising:

a focusing lens group configured to receive
20 said light energy and comprising at least one focusing lens; and

at least one field lens oriented to receive focused light energy from said focusing lens group and provide intermediate light energy; and

25 a Mangin mirror arrangement positioned to receive the intermediate light energy from one field lens and form controlled light energy, said Mangin mirror arrangement imparting the controlled light energy to a specimen with a numerical aperture in excess of 0.65,
30 wherein each lens employed in the objective and each

element in the Mangin mirror arrangement has diameter less than 100 millimeters;

wherein the imaging and illumination subsystems support at least one inspection mode from a group comprising bright field, ring dark field, directional dark field, full sky, aerial imaging, confocal, and fluorescence.

11. The system of claim 10 where the illumination subsystem comprises an arc lamp having an ability to operate at wavelengths from 266-320nm.

12. The system of claim 10 where the illumination subsystem comprises a laser.

13. The system of claim 12 wherein the laser has the ability to provide light energy in at least one from a group comprising 157, 193, 198, 213, 244, 257, 266, 308, 351, 355, and 364nm wavelengths.

14. The system of claim 10, further comprising collection optics, where the collection optics are catadioptric.

15. The system of claim 10, wherein the imaging subsystem uses a varifocal system for full magnification range.

16. The system of claim 10, wherein the imaging subsystem comprises separate imaging lenses, and wherein separate imaging lenses are used for specific magnification increments.

17. The system of claim 10, further comprising a data analysis subsystem for analyzing data representing the light energy reflected from the specimen.

18. A system for inspecting a specimen comprising:

an illumination subsystem comprising an arc lamp that transmits light energy;

5 an imaging subsystem that receives said light energy comprising an objective constructed of a single glass material for use with light energy having a wavelength in the range of approximately 157 nanometers through the infrared light range, said
10 objective comprising:

at least one focusing lens having diameter less than approximately 100 millimeters for receiving said light energy and transmitting focused light energy;

15 at least one field lens having diameter less than approximately 100 millimeters for receiving said focused light energy and transmitting intermediate light energy; and

at least one Mangin mirror element having
20 diameter less than 100 millimeters receiving said intermediate light energy and providing controlled light energy; and

a sensor subsystem for receiving controlled light energy reflected from said specimen.

25 19. The system of claim 18 wherein the sensor subsystem comprises a back thinned sensor.

20. The system of claim 18 wherein the sensor subsystem comprises a sensor operating in a TDI sensing mode.

21. The system of claim 18 wherein the sensor subsystem comprises a sensor having anti-blooming capability.

22. The system of claim 18 where the
5 illumination subsystem comprises an arc lamp having an ability to operate at wavelengths from 266-320nm.

23. The system of claim 18 where the illumination subsystem comprises a laser.

24. The system of claim 20 wherein the laser has
10 the ability to provide light energy in at least one from a group comprising 157, 193, 198, 213, 244, 257, 266, 308, 351, 355, and 364nm wavelengths.

25. The system of claim 18, further comprising collection optics, where the collection optics are
15 catadioptric.

26. The system of claim 18, wherein the imaging subsystem uses a varifocal system for full magnification range.

27. The system of claim 18, wherein the imaging
20 subsystem comprises separate imaging lenses, and wherein separate imaging lenses are used for specific magnification increments.

28. The system of claim 18, further comprising a data analysis subsystem for analyzing data
25 representing the light energy reflected from the specimen.

29. A system for inspecting a specimen comprising:

an illumination subsystem comprising an arc lamp
30 transmitting light energy toward said specimen;

an imaging subsystem comprising:

a plurality of lenses having diameter of less than approximately 25 millimeters receiving the light energy and providing intermediate light energy; and

5 a Mangin mirror arrangement receiving the intermediate light energy and providing controlled light energy to the specimen; and
an autofocus subsystem employing feedback for purposes of focusing the controlled light energy
10 toward the specimen.

30. The system of claim 29, wherein the illumination subsystem comprises a laser.

31. The system of claim 29, further comprising a data acquisition subsystem wherein the data
15 acquisition subsystem employs at least one sensor within an imaging subsystem field of view.

32. The system of claim 29, further comprising a data acquisition subsystem, wherein the data acquisition subsystem employs a plurality of sensors
20 within an imaging subsystem field of view.

33. The system of claim 29, wherein the imaging and illumination subsystems support at least one of a group of inspection modes comprising bright field, ring dark field, directional dark field, full sky,
25 aerial imaging, confocal, and fluorescence.

34. The system of claim 30, wherein the laser has an ability to provide light energy in at least one from a group comprising 157, 193, 198, 213, 244, 257, 266, 308, 351, 355, and 364nm wavelengths.

30 35. The system of claim 29, wherein the illumination subsystem comprises one from a group

comprising a light pipe and lens array to enhance field and/or pupil plane uniformity.

36. The system of claim 29, wherein the illumination subsystem contains one or more axicons
5 for creating ring illumination.

37. The system of claim 29, wherein the illumination subsystem contains a relay with internal field and pupil planes.

38. The system of claim 29, wherein the imaging
10 subsystem comprises multiple objectives on a turret for moving the objectives into proximity of the specimen.

39. The system of claim 29, wherein the imaging subsystem comprises multiple objectives on a stage for
15 moving the objectives into proximity of the specimen.

40. The system of claim 29 where the imaging subsystem includes multiple beamsplitters for accepting light from illumination subsystem, each beamsplitter optimized for a different wavelength
20 range.

41. The system of claim 29 wherein one beamsplitter includes a highly reflective ring to support the ring dark field inspection mode.

42. The system of claim 29 wherein at least one
25 afocal tube lens is employed within the system.

43. The system of claim 29 further comprising a zoom system having an ability to change nominal magnification by at least two per cent in support of cell-to-cell inspection.

44. The system of claim 29, further comprising a sensor and varifocal system, said varifocal system used to form an image on the sensor.

45. The system of claim 29, further comprising a
5 fixed magnification tube lens used to form an image on a sensor.

46. The system of claim 29, wherein the system forms an internal pupil plane, said internal pupil plane available for aperturing and fourier filtering.

10 47. A system for inspecting a specimen comprising:

an illumination subsystem comprising an arc lamp;

an imaging subsystem comprising a catadioptric objective configured to receive light energy from the
15 illumination subsystem, said catadioptric objective comprising:

a catadioptric group comprising at least one element configured to receive light energy and provide reflected light energy;

20 a field lens group comprising at least one field lens receiving the reflected light energy and transmitting resultant light energy; and

a focusing lens group comprising at least one focusing lens receiving resultant light
25 energy and transmitting focused resultant light energy, wherein an imaging numerical aperture for the objective is at least 0.65, the objective having a maximum lens diameter for all lenses employed and a field size, and wherein the ratio
30 of maximum lens diameter to field size is less than 100 to 1; and

a data acquisition subsystem employing at least one sensor within an imaging subsystem field of view.

48. The system of claim 47, wherein the illumination subsystem comprises a laser.

5 49. The system of claim 47, wherein the data acquisition subsystem employs a plurality of sensors within an imaging subsystem field of view.

50. The system of claim 47, wherein the imaging and illumination subsystems support at least one of a
10 group of inspection modes comprising bright field, ring dark field, directional dark field, full sky, aerial imaging, confocal, and fluorescence.

51. The system of claim 48, wherein the laser has an ability to provide light energy in at least one
15 from a group comprising 157, 193, 198, 213, 244, 257, 266, 308, 351, 355, and 364nm wavelengths.

52. A method of imaging a specimen, comprising:
providing light energy using an arc lamp;
focusing received light energy using a focusing
20 lens group;

receiving focused light energy and providing intermediate light energy using a field lens group;
receiving intermediate light energy and forming controlled light energy using a Mangin mirror
25 arrangement;

directing the controlled light energy toward said specimen;

repositioning said specimen to collect data; and sensing data received from said specimen;

30 wherein a field size is supported using the focusing lens group, the field lens group, and the

Mangin mirror arrangement, and wherein a ratio of a largest element in the focusing lens group, field lens group, and Mangin mirror arrangement to field size is less than 100 to 1.

5 53. The method of claim 52, further comprising acquiring data subsequent to said sensing, said acquiring occurring within an imaging field of view.

 54. The method of claim 53, further comprising performing an autofocus function in conjunction
10 with said repositioning.

 55. The method of claim 53, said method employing at least one of a group of inspection modes comprising bright field, ring dark field, directional dark field, full sky, aerial imaging, confocal, and
15 fluorescence.

 56. The method of claim 53, said providing light energy comprising transmitting light energy in at least one from a group comprising 157, 193, 198, 213, 244, 257, 266, 308, 351, 355, and 364nm wavelengths.

20 57. A system for imaging a specimen, comprising:
 arc lamp means for providing light energy;
 means for focusing received light energy using a focusing lens group;
 means for receiving focused light energy and
25 providing intermediate light energy using a field lens group;
 means for receiving intermediate light energy and forming controlled light energy using a Mangin mirror arrangement; and

means for dynamically advantageously positioning said specimen to direct and collect data using a sensor;

wherein a field size is supported using the focusing lens group, the field lens group, and the Mangin mirror arrangement, and wherein a ratio of a largest element in the focusing lens group, field lens group, and Mangin mirror arrangement to field size is less than 100 to 1.

58. The system of claim 57, wherein said specimen positioning means further comprises means for performing a die-to-die comparison to identify a defect on the specimen.

59. The system of claim 58, wherein frame overlap may be adjusted by said specimen positioning means to align a portion of one die with a particular pixel in the sensor subsystem.

60. The system of claim 57, wherein said specimen positioning means further comprises means for performing a cell-to-cell comparison to identify a defect on the sample.

61. The system of claim 57, wherein said specimen positioning means further comprises means for performing a die-to-database comparison to identify a defect on the sample.

62. The system of claim 57, further comprising a data acquisition subsystem wherein the data acquisition subsystem employs at least one sensor within an imaging field of view.

63. The system of claim 62, wherein each sensor is located within a field of view of the imaging subsystem.

64. The system of claim 62, wherein each sensor is physically spaced from any other sensor, and said system forms a field comprising a plurality of portions, each portion of the field being sent to a different sensor.

65. The system of claim 57, wherein the specimen is a partially fabricated integrated circuit.

66. The system of claim 57, wherein said specimen positioning means further comprises an autofocus subsystem.

67. The system of claim 66, wherein said autofocus subsystem uses an astigmatic lens to detect focus shift.

68. The system of claim 66, wherein the autofocus subsystem compares masks and mask images to detect focus shift.

69. The system of claim 3 wherein the arc lamp has the ability to operate at wavelengths from approximately 266-600nm.

70. The system of claim 5 where the catadioptric optics support wavelengths from approximately 266 - 600nm.

71. The system of claim 11 where the arc lamp has the ability to operate at wavelengths between approximately 266-600nm.

72. The system of claim 14 where the catadioptric optics support wavelengths between approximately 266 - 600nm.

73. The system of claim 22 where the arc lamp has the ability to operate at wavelengths between approximately 266-600nm.

74. The system of claim 25 where the
5 catadioptric optics support wavelengths between approximately 266 - 600nm.